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WHAT IS CLAIMED IS:

1 1. An ink jet recording apparatus comprising:
2 an ink jet recording head having nozzle orifices from which inkdrops
3 are ejected;
4 an ink storage unit for storing ink to be supplied to the recording head;
5 an ink flow passage communicating the ink storage unit and the
6 recording head;
7 a valve unit for opening/closing the ink flow passage;
8 a capping unit for sealing the nozzle orifices;
9 a suction pump for reducing pressure in an internal space of the
10 capping unit to discharge inkdrops from the nozzles when the capping unit
11 seals the nozzle orifices; and
12 a control unit for controlling the valve unit, the capping unit and the
13 suction pump in such order that:
14 a) the valve unit closes the ink flow passage;
15 b) the capping unit seals the nozzle orifice;
16 c) the suction pump decompresses the internal space of the capping
17 unit; and
18 d) the valve unit opens the ink flow passage a predetermined time
19 period elapses.

1 2. The ink jet recording apparatus as set forth in claim 1, wherein the
2 control unit controls the valve unit such that the ink flow passage is opened
3 after a predetermined time period has elapsed since the suction pump was

4 stopped driving.

1 3. The ink jet recording apparatus as set forth in claim 1, further
2 comprises a filter member disposed in the ink flow passage.

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1 4. The ink jet recording apparatus as set forth in claim 1, wherein the
2 predetermined time period is defined as either a time period required for
3 obtaining a satisfactory deaeration degree of ink between the valve unit and the
4 nozzle orifices, or a time period required for accumulating air bubbles therein.

but
1 5. An ink jet recording apparatus comprising:
2 an ink jet recording head having nozzle orifices from which ink drops
3 are ejected;
4 an ink storage unit for storing ink to be supplied to the recording head;
5 an ink flow passage communicating the ink storage unit and the
6 recording head;
7 a valve unit for opening/closing the ink flow passage;
8 a capping unit for sealing the nozzle orifices;
9 a suction pump for decompressing an internal space of the capping
10 unit to discharge ink drops from the nozzles when the capping unit seals the
11 nozzle orifices; and
12 a control unit for controlling the valve unit, the capping unit and the
13 suction pump in such order that:
14 a) the valve unit closes the ink flow passage;
15 b) the capping unit seals the nozzle orifice;

16 c) the suction pump decompresses the internal space of the capping
17 unit;
18 d) the valve unit opens the ink flow passage a first predetermined
19 time period elapses; and
20 e) the suction pump continues decompressing the internal space of
21 the capping unit for a second predetermined time period.

1 6. The ink jet recording apparatus as set forth in claim 5, further
2 comprises a filter member disposed in the ink flow passage.

1 7. An ink jet recording apparatus comprising:

2 an ink jet recording head having nozzle orifices from which ink drops
3 are ejected;

4 an ink storage unit for storing ink to be supplied to the recording head;

5 an ink flow passage communicating the ink storage unit and the
6 recording head;

7 a valve unit for opening/closing the ink flow passage;

8 a capping unit for sealing the nozzle orifices;

9 a suction pump for reducing pressure in an internal space of the
10 capping unit to discharge ink drops from the nozzles when the capping unit
11 seals the nozzle orifices; and

12 a control unit for controlling the valve unit, the capping unit and the
13 suction pump in such order that:

14 a) the capping unit seals the nozzle orifice;

15 b) the suction pump decompresses the internal space of the capping

16 unit;

17 c) the valve unit closes the ink flow passage after a first
18 predetermined time period elapses;

19 d) the valve unit opens the ink flow passage a second predetermined
20 time period elapses; and

21 e) the suction pump continues decompressing the internal space of
22 the capping unit for a third predetermined time period.

1 8. The ink jet recording apparatus as set forth in claim 7, further
2 comprises a filter member disposed in the ink flow passage.

1 9. The ink jet recording apparatus as set forth in any one of claims 1, 5,
2 and 7, wherein the ink storage unit is an ink cartridge mounted on a carriage for
3 moving the recording head;

4 wherein the valve unit includes a valve body made of an elastic
5 material through which the ink flow passage; and

6 wherein the ink flow passage is closed by deforming the valve body
7 with an external force.

1 10. The ink jet recording apparatus as set forth in claim 9, wherein the
2 valve unit includes a lever member rotatable around a fulcrum portion thereof
3 when the external force is applied to a first end portion thereof to deform the
4 valve body with a second end portion thereof.

1 11. The ink jet recording apparatus as set forth in claim 10, wherein the
2 lever member includes a pin lever slidably provided at the first end portion
3 thereof to adjust a deforming degree of the valve body, and an elastic member
4 provided between the first end portion and the pin lever.

1 12. The ink jet recording apparatus as set forth in claim 9, further
2 comprises a pad member against which the lever member is to be abutted so
3 as to deform the valve member when the carriage is moved to a predetermined
4 position.

1 13. The ink jet recording apparatus as set forth in claim 9, wherein ink
2 storage unit includes a plurality of ink storage tanks provided for respective
3 colors of ink; and
4 wherein the ink supply passage and the valve unit is provided for the
5 respective ink storage tanks.

1 14. An ink suction method for the ink jet recording apparatus as set forth in
2 claim 9, comprising the steps of:
3 closing the ink flow passage by the valve unit;
4 sealing the nozzle orifices by the capping unit;
5 driving the suction pump to decompress the internal space of the
6 capping unit; and
7 opening the ink flow passage by the valve unit to discharge ink from
8 the nozzle orifices.

1 15. The ink suction method as set forth in claim 14, wherein the suction
2 pump decompress the internal space of the capping unit to accumulate air
3 bubbles in the ink between the valve unit and the nozzle orifices.

1 16. The ink suction method as set forth in claim 14, wherein the steps are
2 executed one time to discharge ink from the nozzle orifices.

1 17. The ink suction method as set forth in claim 14, wherein the steps are
2 repeated predetermined times to discharge ink from the nozzle orifices.

1 18. The ink suction method as set forth in claim 17, wherein the next cycle
2 of the steps is executed after the pressure of the internal space has reached for
3 the atmospheric pressure.

1 19. The ink suction method as set forth in claim 17, wherein the next cycle
2 of the steps is executed before the pressure of the internal space reaches for
3 the atmospheric pressure.

1 20. A cleaning method for the ink jet recording apparatus as set forth in
2 claim 12, comprising the steps of:
3 moving the carriage to the predetermined position to drive the valve
4 unit such that the ink flow passage is closed to prevent the discharged ink and
5 air bubbles from flowing back to the nozzle orifices; and
6 cleaning the nozzle orifices.

1 21. The ink jet recording apparatus as set forth in claim 9, wherein the ink
2 flow passage in the valve body has a cross sectional shape which is
3 asymmetric with respect to a first line extending perpendicular to a direction of
4 which the external force is applied.

1 22. The ink jet recording apparatus as set forth in claim 21, wherein the
2 cross sectional shape of the ink flow passage has an apex arranged on the first
3 line extending on a substantial center of the cross sectional shape.

1 23. The ink jet recording apparatus as set forth in claim 21, wherein the
2 cross sectional shape of the ink flow passage has a rounded corner on a
3 second line extending parallel with the external force direction on a substantial
4 center of the cross sectional shape.

1 24. The ink jet recording apparatus as set forth in claim 21, wherein the
2 cross sectional shape of the ink flow passage has a side extending parallel with
3 the first line and an apex arranged so as to oppose to the side.

1 25. The ink jet recording apparatus as set forth in claim 21, wherein a
2 diameter of the valve body is reduced at a portion where the external force is
3 applied.

1 26. The ink jet recording apparatus as set forth in any one of claims 1, 5
2 and 7, wherein the valve unit includes:

3 a flexible diaphragm which constitutes a part of a side wall of the ink
4 flow passage; and

5 an actuation body for deforming the diaphragm in a direction
6 perpendicular to the ink flow passage for opening/closing the ink flow passage.

1 27. The ink jet recording apparatus as set forth in claim 26, wherein a
2 convex is formed on one face of the diaphragm and the actuation body deforms
3 the diaphragm such that the convex closes the ink flow passage.

1 28. The ink jet recording apparatus as set forth in claim 27, wherein the
2 actuation body is a rod member to press a portion on the other face of the
3 diaphragm where is opposed to the convex.

1 29. The ink jet recording apparatus as set forth in any one of claims 1, 5
2 and 7, wherein the valve unit includes:

3 a flexible diaphragm having a through hole which constitutes a part of
4 the ink flow passage;

5 an actuation body for deforming the diaphragm in a direction of which
6 the through hole extends while closing one opening of the through hole; and

7 a wall member for closing the other opening of the through hole when
8 the diaphragm is deformed by the actuation body to close the ink flow passage.

1 30. The ink jet recording apparatus as set forth in claim 29, wherein the
2 through hole is formed on a substantial center portion of the diaphragm.

1 31. The ink jet recording apparatus as set forth in claim 29, wherein the
2 wall member is arranged an upstream side of the ink flow passage with respect
3 to the diaphragm to constitute a check valve.

1 32. The ink jet recording apparatus as set forth in claim 29, wherein the
2 actuation body includes a spring member for normally urging the diaphragm
3 toward the wall member; and

4 wherein a predetermined or more pressure difference between an
5 upstream side and a downstream side of the ink flow passage with respect to
6 the diaphragm moves the actuation body to open the ink flow passage.

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1 33. The ink jet recording apparatus as set forth in any one of claims 1, 5
2 and 7, wherein the valve unit includes:

3 a valve control chamber which constitutes a part of the ink flow
4 passage;

5 a flexible diaphragm which constitute a bottom wall of the valve control
6 chamber;

7 an actuation body for deforming a center portion of the diaphragm in a
8 direction perpendicular thereto.

1 34. The ink jet recording apparatus as set forth in claim 33, wherein the
2 valve control chamber has an entrance port formed on a top wall thereof at a
3 portion where is away from the center portion of the diaphragm, and an exit port
4 formed on the top wall at right above the center portion of the diaphragm.

1 35. The ink jet recording apparatus as set forth in claim 34, wherein the
2 entrance port is arranged below the exit port.

1 36. The ink jet recording apparatus as set forth in claim 34, wherein the
2 circumferential portion of the exit port is tapered such that a diameter of the port
3 is reduced toward the above.

1 37. The ink jet recording apparatus as set forth in claim 34, wherein the
2 diaphragm includes an annular convex on the center portion thereof for sealing
3 the exit port when the diaphragm is deformed by the actuation body.

1 38. The ink jet recording apparatus as set forth in claim 37, wherein an
2 annular groove is formed so as to surround the exit port, against which the
3 annular convex is to be abutted; and
4 wherein an outer peripheral wall of the groove is tapered such that a diameter
5 of thereof is reduced toward the above.

1 39. The ink jet recording apparatus as set forth in claim 38, wherein a
2 distance between the annular convex and the annular groove is 1.0 - 1.3 mm
3 when the ink flow passage is opened.

1 40. The ink jet recording apparatus as set forth in claim 34, wherein a
2 cross sectional area of the ink flow passage between the exit port and the
3 recording head becomes larger as further from the exit port.

1 41. The ink jet recording apparatus as set forth in claim 33, wherein the
2 actuation body is a rod member arranged below the diaphragm.

1 42. The ink jet recording apparatus as set forth in any one of claims 1, 5
2 and 7, wherein the ink storage unit includes an air hole communicating with
3 atmosphere, and an air valve for opening/closing the air hole; and

4 wherein when pressure in the ink storage unit reaches for a
5 predetermined value under a condition that both of the air hole and the ink flow
6 passage is closed, the air hole is opened prior to the ink flow passage.

1 43. The ink jet recording apparatus as set forth in claim 42, wherein the
2 ink flow passage is still closed even if the air hole is opened.

1 44. The ink jet recording apparatus as set forth in claim 42, wherein the
2 ink storage unit is an ink cartridge.

1 45. The ink jet recording apparatus as set forth in claim 42, wherein the
2 ink storage unit is a subtank to which a main tank replenishes ink.

1 46. The ink jet recording apparatus as set forth in claim 42, wherein the air
2 valve is a check valve.

1 47. The ink jet recording apparatus as set forth in any one of claims 1, 5
2 and 7, wherein the ink storage unit includes an air hole communicating with
3 atmosphere, and an air valve for opening/closing the air hole;

4 wherein a force for closing the air hole is weaker than a force for
5 closing the ink flow passage to discharge internal air of the ink storage unit
6 when pressure inside the ink storage unit is varied due to temperature rising.

1 48. The ink jet recording apparatus as set forth in claim 47, wherein
2 external air is introduced from the air hole when pressure inside the ink storage
3 unit is varied due to temperature dropping.

1 49. The ink jet recording apparatus as set forth in claim 47, wherein the
2 ink storage unit is an ink cartridge.

1 50. The ink jet recording apparatus as set forth in claim 47, wherein the
2 ink storage unit is a subtank to which a main tank replenishes ink.

1 51. The ink jet recording apparatus as set forth in claim 47, wherein the air
2 valve is a check valve.

1 52. The ink jet recording apparatus as set forth in any one of claims 1, 5
2 and 7, wherein the ink storage unit includes:

3 a main tank;

4 a subtank communicated with the main tank via an ink replenishment
5 passage;

6 a main tank connection unit detachably provided with an ink
7 replenishment passage;

8 a decompressor pump for decompressing inside of the subtank to

9 replenish ink from the main tank;
10 a pump connection unit detachably provided with a suction passage
11 connecting the subtank and the decompressor pump;
12 a first valve provided between the pump connection unit and the
13 subtank for opening/closing the suction passage;
14 an air hole provided with the subtank which is opened to communicate
15 with atmosphere when the ink jet recording apparatus executes printing; and
16 an air valve for opening/closing the air hole, and
17 wherein when pressure in the subtank reaches for a predetermined
18 value, the suction passage is opened prior to the ink flow passage.

1 53. The ink jet recording apparatus as set forth in claim 52, wherein the
2 ink flow passage is still closed even if the suction passage is opened.

1 54. The ink jet recording apparatus as set forth in claim 52, wherein the air
2 hole is opened prior to the ink flow passage when the pressure in the subtank
3 exceeds the predetermined value; and
4 wherein the suction passage is opened prior to the ink flow passage
5 when the pressure in the subtank lowers the predetermined value.

1 55. The ink jet recording apparatus as set forth in claim 54, wherein the
2 ink flow passage is still closed even if the suction passage or the air hole is
3 opened.

1 56. The ink jet recording apparatus as set forth in claim 52, wherein the
2 ink storage unit includes a second valve detachably provided on the ink
3 replenishment passage at least between the main tank connection unit and the
4 subtank for opening/closing the ink replenishment passage.

1 57. The ink jet recording apparatus as set forth in claim 57, wherein the
2 second valve is opened according to a pressure difference between the inside
3 and the outside of the subtank when the internal pressure of the subtank
4 becomes a predetermined value or less.

1 58. The ink jet recording apparatus as set forth in claim 52, wherein the air
2 valve is opened according to a pressure difference between the inside and the
3 outside of the subtank when the internal pressure of the subtank becomes a
4 predetermined value or more.

1 59. The ink jet recording apparatus as set forth in claim 52; wherein the
2 first valve is opened according to a pressure difference between the inside and
3 the outside of the subtank when the internal pressure of the subtank becomes a
4 predetermined value or less.

1 60. The ink jet recording apparatus as set forth in any one of claims 1, 5
2 and 7, wherein the ink storage unit includes:
3 a main tank;
4 a subtank communicated with the main tank via an ink replenishment
5 passage;

6 a main tank connection unit detachably provided with an ink
7 replenishment passage;

8 a decompressor pump for decompressing inside of the subtank to
9 replenish ink from the main tank;

10 a pump connection unit detachably provided with a suction passage
11 connecting the subtank and the decompressor pump;

12 a first valve provided between the pump connection unit and the
13 subtank for opening/closing the suction passage;

14 an air hole provided with the subtank which is opened to communicate
15 with atmosphere when the ink jet recording apparatus executes printing; and

16 an air valve for opening/closing the air hole, and

17 wherein the air hole is opened prior to the ink flow passage when
18 pressure in the subtank exceeds a predetermined value, and the suction
19 passage is opened when the pressure in the subtank lowers the predetermined
20 value.

1 61. The ink jet recording apparatus as set forth in claim 60, wherein the
2 ink flow passage is still closed even if the suction passage or the air hole is
3 opened.

1 62. The ink jet recording apparatus as set forth in claim 60, wherein the
2 ink storage unit includes a second valve detachably provided on the ink
3 replenishment passage at least between the main tank connection unit and the
4 subtank for opening/closing the ink replenishment passage.

1 63. The ink jet recording apparatus as set forth in claim 60, wherein the
2 second valve is opened according to a pressure difference between the inside
3 and the outside of the subtank when the internal pressure of the subtank
4 becomes a predetermined value or less.

1 64. The ink jet recording apparatus as set forth in claim 60, wherein the air
2 valve is opened according to a pressure difference between the inside and the
3 outside of the subtank when the internal pressure of the subtank becomes a
4 predetermined value or more.

1 65. The ink jet recording apparatus as set forth in claim 60, wherein the
2 first valve is opened according to a pressure difference between the inside and
3 the outside of the subtank when the internal pressure of the subtank becomes a
4 predetermined value or less.

1 66. A cleaning control method for an ink jet recording apparatus which
2 comprises:

3 an ink jet recording head having nozzle orifices from which ink drops
4 are ejected;

5 an ink storage unit for storing ink to be supplied to the recording head;

6 an ink flow passage communicating the ink storage unit and the
7 recording head;

8 a valve unit for opening/closing the ink flow passage;

9 a capping unit for sealing the nozzle orifices;

10 a suction pump for reducing pressure in an internal space of the capping unit to

11 discharge inkdrops from the nozzles when the capping unit seals the nozzle
12 orifices, the method comprising the steps of:
13 sealing the nozzle orifices by the capping unit;
14 closing the ink flow passage by the valve unit;
15 driving the suction pump to decompress the internal space of the
16 capping unit;
17 holding the decompressed state for a predetermined time period; and
18 opening the ink flow passage by the valve unit.

1 67. The cleaning control method as set forth in claim 66, wherein the
2 sealing step and the closing step are executed synchronously or exchangeably.

1 68. The cleaning control method as set forth in claim 66, wherein the
2 predetermined time period is defined as either a time period required for
3 obtaining a satisfactory deaeration degree of ink between the valve unit and the
4 nozzle orifices, or a time period required for accumulating air bubbles therein.

1 69. A cleaning control method for an ink jet recording apparatus which
2 comprises:
3 an ink jet recording head having nozzle orifices from which inkdrops
4 are ejected;
5 an ink storage unit for storing ink to be supplied to the recording head;
6 an ink flow passage communicating the ink storage unit and the
7 recording head;
8 a valve unit for opening/closing the ink flow passage;

9 a capping unit for sealing the nozzle orifices;
10 a suction pump for reducing pressure in an internal space of the capping unit to
11 discharge ink drops from the nozzles when the capping unit seals the nozzle
12 orifices, the method comprising the steps of:
13 sealing the nozzle orifices by the capping unit;
14 closing the ink flow passage by the valve unit;
15 driving the suction pump to decompress the internal space of the
16 capping unit;
17 holding the decompressed state for a first predetermined time period;
18 and
19 opening the ink flow passage by the valve unit while driving the suction
20 pump.

1 70. The cleaning control method as set forth in claim 69, wherein the
2 sealing step and the closing step are executed synchronously or exchangeably.

1 71. The cleaning control method as set forth in claim 69, further comprises
2 the step of stopping to drive the suction pump after a second predetermined
3 time period has elapsed since the ink flow passage was opened.

1 72. The cleaning control method as set forth in claim 69, further comprises
2 the step of driving the suction pump between the sealing step and the closing
3 step.

1 73. The cleaning control method as set forth in claim 71, further comprises
2 the step of driving the suction pump again after the stopping step has executed.

1 74. The cleaning control method as set forth in claim 73, further comprises
2 the steps of:

3 releasing the capping unit from the nozzle orifices after the suction
4 pump has driven again; and

5 driving the suction pump again to discharge ink from the nozzle
6 orifices in a capping released state.

1 75. A cleaning control method for an ink jet recording apparatus which
2 comprises:

3 an ink jet recording head having nozzle orifices from which inkdrops
4 are ejected;

5 an ink storage unit for storing ink to be supplied to the recording head;

6 an ink flow passage communicating the ink storage unit and the
7 recording head;

8 a valve unit for opening/closing the ink flow passage;

9 a capping unit for sealing the nozzle orifices;

10 a suction pump for reducing pressure in an internal space of the capping unit to
11 discharge inkdrops from the nozzles when the capping unit seals the nozzle
12 orifices, the method comprising the steps of:

13 sealing the nozzle orifices by the capping unit;

14 driving the suction pump to decompress the internal space of the
15 capping unit;

16 closing the ink flow passage by the valve unit;
17 holding the decompressed state for a first predetermined time period;
18 and
19 opening the ink flow passage by the valve unit while driving the suction
20 pump.

1 76. The cleaning control method as set forth in claim 75, further comprises
2 the step of stopping to drive the suction pump after a second predetermined
3 time period has elapsed since the ink flow passage was opened.

1 77. The cleaning control method as set forth in claim 75, further comprises
2 the step of driving the suction pump between the sealing step and the closing
3 step.

1 78. The cleaning control method as set forth in claim 75, further comprises
2 the step of driving the suction pump again after the stopping step has executed.

1 79. The cleaning control method as set forth in claim 75, further comprises
2 the steps of:
3 releasing the capping unit from the nozzle orifices after the suction
4 pump has driven again; and
5 driving the suction pump again to discharge ink from the nozzle
6 orifices in a capping released state.

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